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**Report of the PSARC Invertebrate Subcommittee Meeting,
November 27-29, 2001**

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Pacific Scientific Advice Review Committee
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6**

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INVERTEBRATE

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SUMMARY

The PSARC Invertebrate Subcommittee met November 27 - 29, 2001 at the Pacific Biological Station in Nanaimo. The Subcommittee reviewed five working papers and three stock status reports. Three fishery updates were presented. External participants from Haida Fisheries Program, Oweekeno First Nation and Parks Canada attended the meeting.

Working Paper I2001-06: Quota options for the Red Sea Urchin Fishery in British Columbia for fishing season 2002/2003.

This paper presented the quota options for red sea urchins in B.C. The revised procedures of calculating the density and biomass estimates using only those survey transects in known red urchin beds and a more detailed and sophisticated method for determining the area of red urchin fishing beds, provided a more accurate estimate of red sea urchins available to the fishery. The Subcommittee endorsed the recommendations to continue to work towards improving the process of estimating red sea urchin bed areas, to continue monitoring ports and processing plants, to conduct annual surveys for abundance estimates in alternative areas in B.C. and to continue with biological research to assist with production modelling.

Working Paper I2001-07: Evaluation of a Box Crab trap test in British Columbia.

This paper presented the data collected on the effectiveness of five trap designs in catching box crabs in the northern Strait of Georgia. The Subcommittee recommended the author explicitly state the evaluation criteria for selection of a trap design. The purpose of the survey was to find a trap design, which would catch box crab and have limited bycatch associated with it. The Subcommittee felt that this was accomplished.

Working Paper I2001-08: *Pandalus danae*, Coonstripe shrimp – a review of the biology and a recommended assessment framework for a directed fishery.

This paper presented an in-depth review of all available information on the biology and fisheries of coonstripe shrimp, *Pandalus danae*. The coonstripe shrimp is a by-catch species that has now become a target species and it is a data-limited fishery. The Subcommittee felt that an appropriate assessment and management framework for the development of a directed fishery for coonstripe shrimp in British Columbia was presented. The Subcommittee accepted the paper's recommendations for continued fishery independent surveys, the development of assessment techniques

and collection of the associated biological data for coonstripe shrimp. The Subcommittee felt that this species should follow the framework for emerging fisheries.

Working Paper I2001-09: Further investigation of the fisheries potential of the Exotic Varnish Clam (*Nuttallia obscurata*) in British Columbia.

This paper presented the results of several projects to collect biological and ecological information on varnish clams, *Nuttallia obscurata*, in support of fishery development. Varnish clams, are a recently introduced exotic bivalve that has become well established in southern British Columbia. The Subcommittee supported the paper's recommendations to pursue small-scale commercial opportunities on aquaculture tenures and to continue with research into the basic biology of varnish clams. The Subcommittee recommended that the habitat issues surrounding the development of a wild varnish clam fishery and possible culture fishery be further investigated.

Working Paper I2001-10: A phase '0' review of the biology and fisheries of the Tanner crab *Chionoecetes bairdi*.

This paper provided a review of the published literature on the biology, harvesting methods and fishery performance of Tanner crab (*Chionoecetes bairdi*) and related species focussing on knowledge of stocks in Alaska and Atlantic Canada. The Subcommittee recommended that the New and Emerging Prioritization Model be used to define the priority of *C. bairdi* as a new species/potential fishery. The Subcommittee endorsed the paper's recommendations for the need to collect biological and ecological information on this species on regional scale. The Subcommittee also expressed concern on the potential for the spread of disease in this species and the need to actively manage this issue, learning from the Alaskan experience.

Fishery Updates

Fisheries Management staff, in consultation with Conservation and Protection and Stock Assessment Divisions, prepared fishery updates. Fishery updates for crab, opal squid and green sea urchin were presented at this meeting. The updates provided summaries of commercial fishery performance, including significant management, enforcement and stock assessment activities on an annual basis. The updates provided the opportunity to identify high priority issues that affect assessment and conservation concerns.

Emerging Issues

Four emerging issues were identified by the Subcommittee during the deliberations:

1. The need to develop the scientific basis and the decision rules with respect to potential ecosystems impacts. Specific issues included:
 - Habitat damage and bycatch issues from trap and trawl fisheries (coonstripe shrimp, box crab, Tanner crab).
 - Development of a varnish clam fishery may occur first on existing and new clam tenures, with possible expansion of anti-predator netting covering beaches.
 - Otter impacts: displacement of fishing activity to other areas of the coast due to otter impacts (e.g., red sea urchins, geoducks, dungeness crab, abalone recovery); and, impacts of fisheries on otter population recovery.
2. A new interdepartmental planning process is required with the advent of national marine conservation areas and Species at Risk Act (SARA) legislation.
3. The increasing demand from First Nations and recreational fishers for access to shellfish species (crab, clam, prawn and urchin) requires additional resources for management and assessment methodologies.
4. The future of assessment, management and enforcement of new and emerging fisheries is unknown as a result of the sunset of PFAR (i.e., coonstripe shrimp, Tanner crab *C. bairdi*).

SOMMAIRE

Réuni du 27 au 29 novembre 2001 à la Station biologique du Pacifique, située à Nanaimo, le Sous-comité du CEESP sur les invertébrés examine cinq documents de travail et trois rapports sur l'état des stocks. Trois mises à jour sur des pêches sont également présentées. Des représentants du Haida Fisheries Program, de la Première nation Oweekeno et de Parcs Canada assistent à la réunion à titre de participants externes.

Document de travail I2001-06 : Options de quotas pour la pêche de l'oursin rouge de la Colombie-Britannique en 2002-2003

Ce document présente les options de quotas de l'oursin rouge en C.-B. Les procédures révisées d'estimation de la densité et de la biomasse en ne se fondant que sur les transects de relevés dans les bancs connus d'oursins rouges ainsi qu'une méthode plus détaillée et plus sophistiquée de détermination de la superficie des bancs de pêche de l'oursin rouge ont permis d'accroître l'exactitude de la quantité d'oursins rouges accessibles aux pêcheurs. Le Sous-comité approuve les recommandations visant à poursuivre les travaux d'amélioration de l'estimation de la superficie des bancs d'oursins rouges, à continuer la surveillance aux ports et aux usines de transformation et à réaliser des relevés annuels de l'abondance dans les zones alternatives de la C.-B. et des recherches biologiques pour appuyer la modélisation de la production.

Document de travail I2001-07 : Évaluation de casiers à crabes en Colombie-Britannique

Ce document présente des données sur l'efficacité de capture du crabe à pattes trouées de cinq types de casiers à crabes dans le nord du détroit de Géorgie. Le Sous-comité recommande à l'auteur d'énoncer de façon explicite les critères d'évaluation pour la sélection d'un type de casier. Le relevé avait pour objectif de trouver un type de casier permettant de capturer le crabe à pattes trouées tout en réduisant le plus possible les prises accessoires. Le Sous-comité estime que cela a été réalisé.

Document de travail I2001-08 : *Pandalus danae*, la crevette des quais – revue de sa biologie et cadre d'évaluation recommandé pour une pêche dirigée

Ce document examine de façon approfondie toute l'information disponible sur la biologie et la pêche de la crevette des quais (*Pandalus danae*). Il s'agit d'une crevette qui était capturée de façon accessoire, mais qui est devenue une espèce visée dans le cadre d'une pêche sur laquelle on ne dispose que de données limitées. Le Sous-comité estime que le cadre d'évaluation et de gestion présenté pour le développement d'une pêche dirigée de la crevette à pattes trouées en C.-B. est approprié. Le Sous-comité accepte les recommandations du document quant à

la poursuite des relevés indépendants de la pêche, à l'élaboration de techniques d'évaluation et à la collecte des données biologiques connexes sur la crevette à pattes trouées. Selon le Sous-comité, la pêche de cette espèce devrait se conformer au cadre des pêches en développement.

Document de travail I2001-09 : Études complémentaires sur le potentiel halieutique du bivalve *Nuttallia obscurata* en Colombie-Britannique.

Ce document présente les résultats de plusieurs projets visant à recueillir des données biologiques et écologiques sur le bivalve *Nuttallia obscurata*, pour soutenir le développement d'une pêche de cette espèce. Ce mollusque exotique récemment introduit est maintenant bien établi dans le sud de la Colombie-Britannique. Le Sous-comité approuve les recommandations du document visant à explorer les possibilités d'exploitation commerciale à petite échelle sur des concessions aquacoles et à poursuivre la recherche sur la biologie fondamentale de ce mollusque. Le Sous-comité recommande d'étudier davantage les questions d'habitat liées au développement d'une pêche et d'une éventuelle culture du bivalve.

Document de travail I2001-10 : Examen d'étape 0 de la biologie et des pêches du crabe des neiges du Pacifique (*Chionoecetes bairdi*).

Ce document passe en revue les publications sur la biologie du crabe des neiges du Pacifique (*Chionoecetes bairdi*) et d'espèces apparentées ainsi que sur les méthodes et le rendement de pêche de ces crabes, en mettant l'accent sur les stocks de l'Alaska et du Canada atlantique. Le Sous-comité recommande l'utilisation du modèle de priorisation des pêches nouvelles et en développement pour déterminer le potentiel halieutique de *C. bairdi*. Le Sous-comité approuve les recommandations du document quant au besoin de recueillir, à l'échelle régionale, des données biologiques et écologiques sur cette espèce. S'inquiétant de la possible propagation de maladies chez cette espèce, le Sous-comité indique qu'il faut gérer activement ce problème en tirant des leçons de l'expérience de l'Alaska.

Mises à jour-sur des pêches

En consultation avec la Division de la conservation et de la protection et la Division de l'évaluation des stocks, des employés de la Gestion des pêches ont rédigé des mises à jour sur certaines pêches. Des mises à jour sur les pêches du crabe, du calmar opale et de l'oursin vert sont présentées à cette réunion. Les mises à jour résument le rendement de la pêche commerciale en faisant état des activités notables de gestion, d'application des règlements et d'évaluation des stocks sur une base annuelle. Ces documents offrent l'occasion de relever les questions prioritaires liées à l'évaluation et à la conservation.

Nouveaux enjeux

Dans ses délibérations, le Sous-comité relève quatre nouveaux enjeux :

1. Le besoin d'élaborer le fondement scientifique et les règles de décision concernant les impacts possibles sur l'écosystème. Les enjeux précis comprennent:
 - Les problèmes des prises accessoires et des dommages causés à l'habitat par les pêches au chalut et aux trappes (crevette des quais, crabe à pattes trouées, crabe des neiges du Pacifique).
 - Une pêche du bivalve *Nuttallia obscurata* pourrait d'abord être développée dans des concessions de palourdes existantes et nouvelles, avec l'expansion possible de filets anti-prédateurs couvrant des plages.
 - Les impacts de la loutre de mer entraînent le déplacement des activités de pêche vers d'autres secteurs de la côte (p. ex. oursin rouge, panope, crabe dormeur et rétablissement de l'ormeau); impacts des pêches sur le rétablissement des populations de loutres.
2. L'établissement d'aires marines nationales de conservation et l'adoption de la *Loi sur les espèces en péril* nécessitent un nouveau processus de planification interministériel.
3. La demande croissante d'accès à des mollusques et crustacés (crabes, palourdes, crevettes et oursins) de la part de Premières nations et de pêcheurs récréatifs nécessite des ressources supplémentaires pour établir des méthodes de gestion et d'évaluation.
4. En raison de la fin du PARPC, l'avenir de l'évaluation, de la gestion et de l'application des règlements concernant les pêches nouvelles et en développement (c.-à-d. crevette des quais et crabe des neiges du Pacifique, *C. bairdi*) est incertain.

INTRODUCTION

The Subcommittee met on November 19 – 20, 2001 at the Pacific Biological Station in Nanaimo, B.C. The Subcommittee Chair opened the meeting welcoming the participants. During the introductory remarks the objectives of the meeting were reviewed and the Subcommittee accepted the meeting agenda (Appendix 1).

The Subcommittee reviewed five Working Papers. Working Paper titles and authors and reviewers are listed in Appendix 2. Three fishery updates were presented and three stock status reports were reviewed. A list of meeting participants is included as Appendix 3.

General Subcommittee Discussion and Concerns

Four issues emerged from the meeting for special consideration:

1. Ecosystem impacts

The Subcommittee had a long discussion on the need for the Department to develop the scientific background and the decision rules with respect to potential ecosystem impacts of fishing activities. This issue was raised in a number of papers in particular in discussions around the trap and trawl fisheries and the potential for habitat damage and bycatch issues (coonstripe shrimp, box crab, Tanner crab). In addition, ecosystem impacts in intertidal habitats may be an issue in a potential varnish clam fishery. For example, if varnish clams became an important fishery on existing and/or new clam tenures, there may be pressure to increase the area of the beach covered by anti-predator nets. Ecosystem impacts were key in the discussions around sea otter impacts (e.g., red sea urchins, geoducks, dungeness crab and abalone recovery). Reduction of these species by otters may result in displacements of fishing activities to other areas of the coast; conversely, these fisheries may also impact the rebuilding of the otter populations.

2. Planning process development

The advent of national marine conservation areas (under the jurisdiction of Parks Canada) and SARA legislation require an interdepartmental planning process. The Subcommittee felt that coordinated participation was required by the Department on these various planning initiatives. This would include the Haida Gwaii region marine invertebrate baseline initiative by Parks Canada.

3. First Nations and recreational access to shellfish

Increasing demand from First Nations and recreational fishers for access to shellfish species (crab, clam, prawn and urchin) will require additional resources for management and assessment methodologies. The Subcommittee felt that this

increased funding requirement was a significant challenge to the existing resources and should be brought to Senior Management's attention.

4. New and emerging fisheries

The future of assessment, management and enforcement of new and emerging fisheries is unknown as a result of the sunset of PFAR. This is of particular concern for coonstripe shrimp, Tanner crab (*bairdi*), box crab and varnish clam, all of which were reviewed at this meeting and meet the criteria for new and developing fisheries. The Subcommittee was concerned that there are a number of shellfish species for which the assessment and management activities are following the phased approach to new and developing fisheries, but these activities will be left unfunded at the end of the PFAR program.

WORKING PAPER SUMMARIES, REVIEWS AND DISCUSSION

I2001-06: Quota options for the Red Sea Urchin Fishery in British Columbia for fishing season 2002/2003.

A. Campbell, D. Tzotzos, W.C. Hajas, and L. Barton

Accepted subject to revisions

Summary

Annual landings of red sea urchin (*Strongylocentrotus franciscanus*) increased rapidly in the early 1980s for the south coast of British Columbia (B.C.) and in the late 1980s for the north coast, but subsequently were reduced and stabilised by quotas. Coastwide landings were 4,815.4 t valued at approximately \$8.4 M (Cdn.), with 110 licenses issued during the 2000/2001 fishing season. Bed areas were obtained by digitising locations on charts indicated in harvest logbooks during 1997-2000. Analyses of surveys, during 1994-2001, provided estimates of mean density and weights of red sea urchin biomass within beds. Natural mortality rates of red sea urchins were assumed, for fishery management purposes, to be between 0.075 and 0.15. The minimum size limit was reduced from 100 mm to 90 mm test diameter (TD) for the 2000-2001 fishing season. Of the total (N = 22,739) measured in a survey of red sea urchins in processing plants, harvested throughout the 2000-2001 fishing season, the majority (95.0%) was in the 95-140 mm TD size group and only a few (4.3%) were < 95 mm TD. Biomass and quota options (Table 1) were estimated for a variety of size limits (e.g., ≥ 90 , ≥ 95 , ≥ 100 , 95-140 mm TD) for red sea urchins in B.C. Further surveys for red sea urchin density are required in areas of B.C. where surveys are > 5 years old, and that have been heavily fished and or invaded by sea otters. Reliable biomass estimates and accurate estimates of bed areas, natural mortality and recruitment rates for red sea urchins in most areas of B.C. are required to manage this fishery effectively.

Working Paper Recommendations

- (1) If the size limit of ≥ 90 mm TD is to be maintained, we recommend that a precautionary approach could include a quota based on a low fishing mortality of < 0.02 ($M < 0.10$) and a size range of 90 – 140 mm TD.
- (2) Continue improving the process of estimating bed areas holding viable populations of red sea urchins. Bed areas fished on an annual basis need to be recorded, validated, digitized and updated.
- (3) Continue monitoring harvested red sea urchins at ports and or at commercial processing plants which will provide temporal changes and area differences in size frequency, mean weights, and gonad quality of commercial-sized individuals, and provide a tool to assess the appropriate size range to set quotas in the future.
- (4) Surveys for the abundance estimates of red sea urchins in alternative areas in B.C. should be conducted on an annual basis. Areas with no surveys for over 5 years and areas that have been heavily fished should be considered a priority.
- (5) Further research is required to understand age, and growth, mortality and recruitment rates of red sea urchins in B.C. to assist with production modeling

Reviewers' Comments

Reviewer #1

The reviewer notes that this is a challenging fishery to manage and the authors have done a good job recognizing these challenges, reviewing available literature, summarizing available data, and identifying areas of additional research. The reviewer feels the data and methods have sufficient detail to evaluate and support the conclusions but would like clearer explanation of the dockside validation and logbook programs and a clearer explanation of the rationale for decreasing the size limit from 100 mm to 90 mm. The reviewer concurs with the author's cautionary notes on using surveys older than 4 years and about estimating bed size and the proportion of suitable substrate types and the adoption of the Woodby (1992) method. The reviewer emphasizes the author's point that CPUE needs to be examined on a smaller spatial scale suggesting that this may be facilitated by an area rotational fishery. He feels that by presenting biomass and quota estimates for a variety of M values, size ranges, and density estimates the fishery manager is provided clear choices and alternatives. The reviewer endorses all the authors' recommendations.

Reviewer #2

The reviewer complimented the authors on a thorough paper and for their continued improvements to the methods used to determine the status of red urchin populations in B.C. The authors have revised their procedures from previous papers in two important ways: (i) by calculating density and biomass estimates using only those survey transects which actually occurred within known red urchin beds ("clipped" transects); and (ii) by using a more detailed and sophisticated method for determining the areas of red urchin fishing beds. This reviewer had no major concerns with the paper, but did include a number of technical issues for consideration and revision. These included more detailed explanations for the 40% decline in bed areas calculated between 1982-1996 and 1997-2000; to begin now to look for evidence of serial depletion of red urchin beds; further exploration of the use of CPUE as an abundance index in combination with geographic mapping; and improved alternatives to the use of the very simple model for setting quotas in this fishery.

Subcommittee Discussion

Subcommittee discussion focused on the following issues: Sea otter predation, codifying bed status (loss), ecosystem considerations, survey design, selection of the best density estimator for computing biomass, evaluation of variance components, experimental determination of mortality rates, the number of years of data to use in estimating bed areas, serial depletion and size limits.

Several suggestions were made during the discussion. Many of the beds identified in the early days of the fishery may not have been actual beds but just areas where fishermen suspected urchins would be present. An On Ground Monitor (OGM) work in conjunction with the harvesters to characterize and track bed condition (status) similar to the geoduck fishery could be extremely difficult with the larger number of vessels in the red sea urchin fishery. Fishermen's knowledge could be incorporated into the assessment process by encouraging them to come forward with personal knowledge of the resource. The impact of both the red sea urchin fishery and sea otter predation could be incorporated into an ecosystem section or statement within the current assessment to acknowledge that both improve algal abundance and diversity which may impact on other fisheries resources (marine species).

The new assessment approach computed biomass using only density estimates from survey transects which occurred within reported beds. The future research program should allocate the large majority of survey effort to known beds and a smaller proportion to randomly selected transects outside the known beds. Because transects outside known beds permit the identification of previously unknown beds and the collection of biological data from unexploited areas the Subcommittee endorsed this approach.

The merit of adopting the Woodby method, using the lower 90% confidence interval of the density estimate to compute biomass, was discussed. The consensus was that there was sufficient caution in other features of the quota estimation process so that retaining the mean survey density estimate for biomass computations was still appropriate. These "other features" include the approximate 2% harvest rate, and a conservative estimation of total bed area based on the last three seasons of data.

Exploitation rates are linked to natural mortality rates. Natural mortality at this time is unknown for this animal and there was some discussion of initiating studies to directly measure natural mortality in red sea urchin in B.C., and test the appropriateness of varying exploitation rates.

It was noted that the estimate of digitized urchin beds tends to increase over time as subsequent years of data are added to the spatial database due to the overlap and consolidation of urchin bed polygons. Because bed area is probably the most variable and poorly understood parameter in computing biomass there was some discussion of the appropriate number of years of data to use in estimating bed areas. The authors acknowledged this feature of the analysis but noted that at this point there are not enough data (3 seasons) to undertake an analysis that would answer this question.

Because certain beds appeared to have been abandoned over the course of the fishery the Subcommittee expressed concern over the possibility of serial depletion over time and asked the authors if there was any evidence of this in the current data. The authors stated that there were insufficient data to address that concern at the present time. It was suggested that any beds that have produced significant quantities of urchins in the past but are presently not fished be examined for evidence of serial depletion and should be re-surveyed.

After several years of industry lobbying for a lower size limit to access higher quality and higher value urchins in the 90-100 mm TD size range the current commercial sampling program shows that only a very small proportion of the landed urchins are under 95 mm. It seems that fishermen really just want access to urchins of ~ 100 mm TD and the reduced size limit increases product quality and reduces the likelihood that they will harvest undersize animals. Discussion ensued around the recommended upper size limit (140 mm) for red sea urchin as to whether it would be enforceable.

Subcommittee Recommendations

The Subcommittee recommended the paper be accepted subject to revisions.

- (1) The Subcommittee endorsed the maintenance of the ≥ 90 mm TD size limit and the inclusion of a maximum size of 140 mm TD with the proviso that the

upper size limit is solely for the purposes of assessment and not to be imposed as a regulation.

- (2) The Subcommittee endorsed the process of estimating bed areas based on areas holding commercial aggregations of red sea urchins. Bed areas fished on an annual basis need to be recorded, validated, digitized and updated.
- (3) The Subcommittee endorsed the continued monitoring of harvested red sea urchins at ports and or at commercial processing plants and felt that surveys for the abundance estimates of red sea urchins in alternative areas in B.C. should be conducted on an annual basis. Areas with no surveys for over 5 years and areas that have been heavily fished were felt to be a priority.
- (4) The Subcommittee supported the need for further research to understand age, and growth, mortality and recruitment rates of red sea urchins in B.C. to assist with production modeling
- (5) The Subcommittee endorsed the use of the Bed by Bed assessment approach and the use of mean survey density estimates to compute biomass as used by the authors in this assessment.
- (6) The Subcommittee recommended the development of bed status codes.
- (7) The Subcommittee recommended that some survey effort outside known beds be continued.

I2001-07: Evaluation of a Box Crab Trap Test in British Columbia.

Z. Zhang **Accepted with major revisions**

Summary

Effectiveness of five trap designs (large circular trap, modified Dungeness trap, prawn trap, Dorian top-loading trap, and Ladner top-loading trap) in catching box crabs was tested in the northern Strait of Georgia in April 2001. Altogether 102 sets were made and 1724 box crabs were caught (1096 males, 628 females). The modified Dungeness trap appears to be most suitable for future surveys and a potential box crab fishery based on an overall evaluation of the box crab catch rate, convenience of trap deployment, and the amount of by-catch. The paper also presents some new biological features on box crabs revealed by this test survey, such as size and sex composition and distribution, relationship between size and weight, relative abundance, shell conditions, relative number of egg-bearing females for different size groups. The paper also proposes some recommendations as how we should proceed in the development of this potential fishery.

Working Paper Recommendations

- (1) The preferred trap type is type 2 (modified Dungeness trap).
- (2) The soak duration should be, at least, two-nights long instead of overnight.
- (3) Only male box crab larger than 110 mm in carapace length may be removed.
- (4) To estimate population abundance a systematic survey is to be carried out to gain more detailed information on box crab biology, abundance, reproductive characteristics and distribution.

Reviewers' Comments

Reviewer #1

The reviewer raised concerns that too many variables in trap tests were allowed to change during the experiment resulting in too few replicates to fully test various trap designs. Recommendations were also made that the paper would benefit from a more thorough description of the survey design and how it related to the objectives of this work.

The reviewer felt that the purpose of the paper was clearly stated, but felt that the data and methods did not always support the conclusions. It was also stated that the data were not explained in sufficient detail, to support all of the recommendations within the paper. Some suggestions were forwarded on additional information and studies the author should consider – including a distributional survey specifying trap type, depth, bait load, soak time, and transect density.

The reviewer raised a number of specific points addressing survey location, design, and trapping efficiency.

Subcommittee Discussion

In response to the reviewer's comments the author responded that the design was not set up to test all variables, and that the data do not allow comparison of bait type, etc. The author discussed the criteria for selecting a preferred trap type, and mentioned that there were non-scientific factors involved such as size for ease of fishing.

The Subcommittee discussed the timing of the survey and how it may have impacted on the experimental results, and also commented that repeating the analysis for another location would help verify the standardization among gear types.

The Subcommittee raised questions regarding table 3 in the paper, and questioned why catch rates would decrease on longer soaks. There was also a

suggestion that size frequency graphs be re-examined at smaller size intervals in order to identify age modes in the graph.

The Subcommittee raised serious concerns around the limitations in the data regarding uncontrolled variables, and the inability to form strong conclusions from the data. The Subcommittee also had lengthy discussions on the criteria for a "preferred" trap type, which might include different handling characteristics, selectivity, and replication, according to the objectives of the program. One of the primary objectives of the study was to identify if traps of various designs could catch box crabs, and subsequently which design would be best suited for future distributional studies. It was felt that this had been achieved.

Subcommittee Recommendations

The paper was accepted subject to major revisions. Revisions will be reviewed by the Subcommittee chair, along with a sub-group from the Subcommittee.

- (1) The Subcommittee felt that recommendation #1 seemed reasonable subject to clarification of the trap selection criteria.
- (2) The Subcommittee did not support recommendation #2 from the paper, but noted that experimentation on soak times and trap types should be conducted if the Department proceeds with any type of fishery.
- (3) The Subcommittee did not support recommendation #3 from the paper as the size limit deals with a change in ratio type fishing experiment, which was not discussed in this paper.
- (4) The Subcommittee did not support recommendation #4 at this stage. This should, however, be considered following a distribution survey. The Subcommittee would like to review any future protocols for change in ratio fishing tests prior to implementation, because of the potential impacts to the stock.

I2001-08: *Pandalus danae*, Coonstripe Shrimp – a review of the Biology and a recommended assessment framework for a directed fishery.

J.S. Dunham and J.A. Boutillier **Accepted with revisions**

Summary

In September 2001, Fisheries and Oceans Canada adopted the final version of the national policy on new and emerging fisheries. This national process incorporates principles that cover issues concerning: conservation, the precautionary approach, ecological considerations, science-based research, First Nations, transparency of

process, accountability and responsibility. In response to this document the Pacific Region has developed an implementation framework for new and emerging fisheries which covers four stages: information; experimentation; exploration; and objective-based fishery management. This paper was produced to meet stage 1 requirements which is an in-depth review of all available information for a fishery for coonstripe shrimp, *Pandalus danae*. The coonstripe fishery falls under the definition of emerging fisheries for two reasons: it is a by-catch species that has now become a target species and it is a data-limited fishery. The paper presents a review of what is known about the biology and the fishing history of these animals around the world. From this review the paper presents an appropriate assessment and management framework for the development of a directed fishery for coonstripe shrimp in British Columbia.

Important aspects of the biology of coonstripe shrimp that the assessment framework addresses include the variable growth rates shrimp exhibit between areas, the ability of coonstripe shrimp to produce primary females, and the potential multiparous nature of these animals.

The paper concludes that there is potential for a targeted coonstripe shrimp fishery within BC's coastal waters. There are a number of suggestions about how this fishery may proceed under a precautionary framework. The key aspects of the precautionary framework included: removal of specific areas from other trap and trawl shrimp fisheries; recommendations regarding target and limit reference points; and adoption of an experimental management approach to address knowledge gaps e.g. assessment methodologies, appropriate exploitation levels, reproductive potential etc.

Working Paper Recommendations

1. Targeted fisheries, both trap and trawl, on coonstripe shrimp should fall under the Pacific framework for emerging fisheries.
2. Fisheries should be initially developed using a fixed exploitation rate with the intention of possibly moving towards a fixed escapement policy in the future.
3. Data should be collected to determine the appropriateness of fixed escapement targets, since maximum production and lowest cost would be achieved through a fixed escapement policy. --
4. Fishery independent surveys should be conducted to provide assessment information.
5. Fishery independent surveys and catch validation or monitoring will be required to understand fishery impacts.
6. Collection of abiotic (environmental) and biotic information is necessary.
7. The most selective fishing method or gear should be determined and utilized.
8. Protocols for environmental impacts should be developed as part of the selective fishing criteria.

Reviewers' Comments

Reviewer #1

The reviewer noted that this paper provides a good review of the biology and the fishery of coonstripe shrimp. The reviewer recognized that the shrimp trawl fishery is troublesome, especially with respect to by-catch of other species, fishery related mortality of juvenile shrimp, and possible degradation of habitat and biodiversity. The lack of knowledge about the possible impacts of the trawl fishery and potential fishing effort from 500 vessels (trap and trawl) in a limited number of areas clearly requires a precautionary approach be implemented as soon as possible. The reviewer noted the paper is timely and well considered.

The reviewer felt that the recommendations could be more precise and that some discussion aspects of the recommendations could be moved to the discussion/conclusion section. The reviewer also indicated that there was not enough discussion around the possible experimental management approaches. It was also questioned whether a full review of the Pandalidae biology was necessary in the paper, and it was suggested that it be condensed and combined with the section on coonstripe shrimp biology.

The reviewer raised a number of specific points addressing CPUE and methodology of fishery independent abundance surveys.

Reviewer #2

The reviewer complimented the authors on a thorough and well-organized paper.

The reviewer noted that in the discussion of commercial trap and trawl fisheries in BC it would have been beneficial to include numbers of vessels targeting coonstripe shrimp. The reviewer also suggested including a discussion on the economic realities of developing the appropriate data and management system for a small fishery with no "fishing history". The reviewer also noted that in order to put the current coonstripe fishery in BC into perspective it would be useful to include the percentage of coonstripe landings that is by-catch.

Subcommittee Discussion

The Subcommittee discussion focussed on the following key issues: difficulties in assessment, management issues, recent fisheries targeting on coonstripes, environmental impacts of fishing activity, and reliability of older literature.

Assessment of this fishery is difficult for a variety of reasons including the presence of primary females, lack of historical information to develop tools such as spawner indices, and the presence of small isolated coonstripe populations. In addition, it

was noted that the current survey design was developed for mixed shrimp species in the trawl fishery and not for a targeted coonstripe fishery.

It was suggested that developing a management strategy might be more difficult as two shrimp fisheries (trap and trawl) already exist where retention of coonstripe shrimp is permitted. However, it was indicated that there have been changes to the commercial trawl fishery in BC and that there are some small areas (or Subareas) where fishers are targeting coonstripe shrimp. The targeted coonstripe fisheries should be included under the Pacific framework for new and emerging fisheries since this framework provides flexibility for assessment and management approaches. It was stated that a precautionary approach for this species should be adopted.

Environmental impacts of both trap and trawl fisheries were highlighted as an emerging issue. Gaining more information about these impacts should be made a priority.

There was a brief discussion of older literature cited in the paper with respect to limited larval dispersal and discreteness of coonstripe populations. More work on the discreteness of coonstripe population is needed considering that populations might be associated with bottom substrate or aggregated by hydrographic processes.

Subcommittee Recommendations

The Subcommittee accepts the paper subject to minor revisions.

1. The Subcommittee accepts the recommendation that targeted fisheries, both trap and trawl, on coonstripe shrimp should be moved into the Pacific framework for emerging fisheries, with the recognition that there are difficulties due to the current harvest in the existing fisheries.
2. The Subcommittee accepts recommendations #2 and #3 that fisheries should be managed initially using a fixed exploitation rate while collecting the data required to assess the appropriateness of management by a fixed escapement.
3. The Subcommittee accepts recommendation #4 to expand and modify fishery independent surveys on this targeted species.
4. The Subcommittee accepts the recommendation supporting the need for catch monitoring.
5. The Subcommittee accepts that more information on basic biology and ecological requirements of coonstripe shrimp is needed.
6. The Subcommittee recognizes the need to adhere to policies on selective fishing and environmental impacts.

I2001-09: Further investigation of the fisheries potential of the Exotic Varnish Clam (*Nuttallia obscurata*) in British Columbia.

G. Gillespie, B. Rusch, S.J. Gormican, R. Marshall and D. Munroe

****Accepted with minor revisions****

Summary

Varnish clams, *Nuttallia obscurata*, are a recently introduced exotic bivalve that has become well established in southern British Columbia. This species has attracted attention from commercial and recreational fishers and clam culturists, and has been identified as a potentially valuable fishery resource. This paper presents the results of several projects to collect biological and ecological information on varnish clams, in support of fishery development.

The distribution of varnish clams in British Columbia continued to expand beyond the Strait of Georgia into Johnstone Strait and north along the West Coast of Vancouver Island. They were found associated with other commercially important bivalves including Manila and littleneck clams, *Venerupis philippinarum* and *Protothaca staminea*, respectively, although generally higher in the intertidal zone. Varnish clam distribution extended deeper in the intertidal zone on beaches that did not support large populations of Manila clams.

Experiments to examine competitive relationships between varnish and Manila clams showed evidence of competition when the two were placed together, with varnish clams having some competitive advantage in the upper intertidal zone and Manilas showing advantage in the mid-intertidal zone.

Characteristics of harvest and processing of varnish clams were examined. Varnish clams >30 mm total length were harvested from mixed populations. Harvest efficiency was relatively high, 60-80%, for this size class. Breakage during harvest was low at approximately 2%, and shrinkage during processing was approximately 4%, evenly divided between weight loss due to water loss and losses due to mortality. Grit was purged readily from clams during wet storage within 48 hours. Commensal pea crabs, *Pinnixia faba*, were not purged from varnish clams even after 34 days of storage.

Successful development of a varnish clam fishery depends on a consistent supply for market development. This could be achieved by allowing harvests of varnish clams from tenured foreshore under aquaculture permits. As the market becomes established, demand and price would allow for economically viable commercial fishing opportunities. Further work is required to develop biologically based reference points for management of a sustainable commercial fishery.

Working Paper Recommendations

1. Proceed with implementation of monitored small-scale commercial opportunities through the regular commercial fishery.
2. Continue research into basic biology of varnish clams in British Columbia.

Reviewers' Comments

Reviewer #1

Reviewer 1 found the paper to be well written and complete, and had only minor comments. The reviewer requested a better description of sample processing, since the method used can have an effect on the numbers and sizes of clams collected. He also questioned the statement that varnish clams have a wider vertical extent in the absence of manila and littleneck clams, stating that personal experience has led to an impression of strong habitat factors. Suggestions for further work include an assessment of the vulnerability of varnish clams to PSP, and a possible seasonal effect on meat quality.

Reviewer #2

Reviewer 2 was complimentary, finding the presentation of material to be clearly stated and complete, and urged the authors to publish the report in the primary literature. Additional comments were of a minor editorial nature or points of agreement.

Subcommittee Discussion

The Subcommittee identified that the species may be spread to other regions through shipping of live product, should a fishery occur.

It was noted that harvest of wild stocks on tenures may lead to directed culture activities. Varnish clam culture, which would be higher on the intertidal, than species currently being grown, may lead to increased use of predator-exclusion netting and greater impacts on habitat and bird feeding.

It was noted that the bag limit for Varnish clams in the recreational fishery is low and needs to be reviewed.

Subcommittee Recommendations

The paper was accepted subject to minor revisions.

- (1) The Subcommittee supported to proceed with small-scale commercial opportunities with sampling programs designed to collect data appropriate for stock assessment to evaluate stock response to harvesting pressure.
- (2) The Subcommittee supported recommendation #3, to continue research into basic biology of varnish clams for the development of biologically defensible size limits and parameter estimation for production models.
- (3) The Subcommittee further recommends that habitat issues around the development of varnish clam culture be referred to the PSARC Habitat Subcommittee.

I2001-10: A phase '0' review of the biology and fisheries of the Tanner crab *Chionoecetes bairdi*.

G. Krause, G. Workman and A. Phillips **Accepted with revisions**

Summary

The Tanner crab (*Chionoecetes bairdi*) may present some potential as a candidate for a largely inshore developmental trap fishery in British Columbia. Significant fisheries targeting Tanner and related crabs have been carried on in Alaska, Japan and the Canadian Maritimes for some years and considerable information on their biology has been accumulated. This document comprises a review of available information on these crab in scientific literature. Biological data identified as particularly pertinent to the fishery development process by Perry et al (1999) are summarized although it should be noted that these data are largely derived from fished Alaskan stocks which are likely considerably different than BC stocks. Data on *C. bairdi* in BC were assembled from a number of sources, including exploratory efforts and bycatch data from other fisheries, and are presented.

Tanner crab fisheries appear to follow a 'typical' pattern of development as production and effort quickly rise through the exploratory phase followed by cyclic catch variation over a few decades followed by a dramatic decline in abundance. This is mediated by a number of factors, including possible environmental and natural abundance variations but, in Alaska at least, the end result has been generally characterized as a serial depletion of the stocks as the fishing effort radiates further from fishing ports onto stocks which have not been exploited as a means to maintain high catch levels. Few affected stocks have recovered once so depleted, highlighting the need for caution as the potential for a sustainable fishery is defined.

These crab are widely distributed in BC waters. The data gathered thus far suggest there are significant differences in the biological characteristics of *C. bairdi* crab in different areas of BC, supporting the hypothesis that the animals occur primarily as discrete inlet stocks with limited exchange between areas. The information available on the specific biological features of the animals in each area is however limited and data on local abundance(s), growth, maximum size, population structure(s), spatial reproductive scale and continuity, mortality, fecundity, spawning, migration patterns, aggregating behaviours and locations etc. are required.

Preliminary reconnaissance surveys using standardized Tanner crab pots followed by more detailed surveys using standardized pot, underwater video and/or other sensing technologies in identified areas of interest are recommended to obtain information required to define local stock characteristics as part of the developmental process. Tissue samples from each area for genetic research are recommended as a means to identify or verify separate stocks and to investigate any linkages and exchanges between different stocks and including possible dispersal patterns. Tagging studies to investigate local movement(s) and growth patterns of the crab are also recommended.

Working Paper Recommendations

1. Basic biological and ecological characteristics of the animals in British Columbia waters must be investigated and resolved on a local scale before the biological or economic viability of any targeted commercial activity can be assessed.
2. Preliminary exploratory efforts are recommended to investigate the following: distribution, abundance, growth, population characteristics including age, size and maturity, migration patterns, spawning seasons and locations, stock composition, egg brood duration, disease and parasite infection rates, natural mortality rate(s), critical habitat, etc.
3. Initial reconnaissance surveys using appropriate and standardized Tanner crab pots should be undertaken.
4. Biological samples should be collected from all areas surveyed for a tissue bank for genetic profiling studies.
5. Any future commercial activities targeting these crab should:
 - use standardized gear --
 - be monitored by observers and dockside validation
 - be managed on a small spatial scale until stock unit size and composition can be determined.
6. The eventual establishment of closed reference areas is recommended once appropriately sized and located reserves can be identified during the 'Phase 1 "Fishing for Information" stage. These areas will act as reference (control) areas as the fishery develops and allow retention of the option to rebuild stocks outside these areas should such a capability be required.

7. Adaptive management experiments should be initiated and selected areas should be fished at different exploitation rates to obtain data on the population response(s) and to test a variety of management strategies. It should be noted that the requirements for each area are likely to be at least somewhat unique and that a generalized solution applicable to all areas (inlets) may prove illusory.

Reviewers' Comments

Reviewer #1

The reviewer thought that the stated purpose of the working paper should be expanded because the paper provided more than a summary of existing information for the precautionary development of a new Tanner crab fishery. The data and methods were adequate to support the conclusions.

There should be more effort to identify lessons learned in other *Chionoecetes* fisheries. It is important to reveal deficiencies of assessment and management measures and the authors should clearly state what role these measures play in development of a potential Tanner crab fishery in B.C. For example the authors described a number of surveys in B.C. but did not discuss information such as proportion of soft shell crabs, an indicator used in Atlantic snow crab (*C. opilio*) fisheries as a reference point.

Reviewer #2

The reviewer felt this working paper was a good review of life history information. The reviewer requested the speculation in the paper be removed and provided some specific information on the S.E. Alaskan experience. The reviewer thought the discussion of the 'ecological setting' was unclear. The recommendations to managers are well thought out. Consideration of reserve areas and adaptive management strategies are appropriate given the history of exploitation of this species. Recommendations on avoiding the spread of Bitter Crab Syndrome should be included in the paper.

Subcommittee Discussion

The Subcommittee recognized the wealth of information presented in the paper, but felt the focus was lost because of the length. Some of the information was perceived to be better suited to be presented in an attachment.

Subcommittee Recommendations

The Subcommittee recommended that the paper be accepted with revisions.

- (1) The Subcommittee agrees with recommendations 1, 2 and 4 – the need to collect biological and ecological information on *C. bairdi* on a local scale.
- (2) The Subcommittee agrees with recommendation 3. Fishery independent surveys should be included as part of the assessment methodology.
- (3) The Subcommittee agrees with recommendations 5, 6 and 7, that refugia and adaptive experiments are appropriate precautionary approaches for discrete stocks that may have varying biological and productive influences.
- (4) The Subcommittee recommended that the New and Emerging Fisheries Prioritization Model be used to define the priority of *C. bairdi* as a new species/potential fishery and to determine if resources should be dedicated towards this species: Fishery development should follow the phased approach framework.
- (5) The Subcommittee recommended that a mechanism be developed to manage bitter crab disease.

Living marine legacy of Gwaii Haanas. II. Marine invertebrate baseline to 2000 and invertebrate-related management issues. Parks Canada. Technical Reports in Ecosystem Science.

N.A. Sloan, P.M. Bartier & W.C. Austin.

An update on the Haida Gwaii marine biological inventory baseline document was presented to the Subcommittee by N. Sloan.

This is the second report in a series of baseline marine biological inventories for the Haida Gwaii (Queen Charlotte Islands) region including the proposed marine component of Gwaii Haanas National Park Reserve/Haida Heritage Site. We list the marine invertebrate species known from the intertidal to the deep-sea and map some of their distributions known to the end of 2000. Our geographic information system contains ~25,000 records of ~2,503 invertebrate species from ~2,900 localities in a spatio-temporal database. Regional biogeographic comparisons and invertebrate biodiversity-habitat generalisations are made. Aboriginal (Haida) uses of, and words for, invertebrates are recounted. All the archipelago's commercial and recreational invertebrate fisheries and their management are described. The contributions of marine invertebrate issues to future management of the Gwaii Haanas marine area, noteworthy data gaps and management recommendations are discussed.

Subcommittee discussion

The Subcommittee expressed interest in the long-term objectives of this GIS database and felt it would be relevant to provide access to this database through an Internet website. The Subcommittee encouraged the continuation of this type of work and suggested a collaborative monitoring program be initiated coastwide.

FISHERY UPDATES

The Subcommittee discussed the future role and value of the Fishery Updates and felt that the Fishery Update was more appropriately associated with Shellfish Working Group (SWG). The Subcommittee felt strongly that prior to the transfer of Fishery Updates to the SWG, assurance on an upward reporting structure was essential. Issues emerging from the Fishery Updates need an avenue in which to go forward in a timely manner for information and advice to Senior Management.

The Subcommittee recommended that the venue for Fishery Updates be the SWG, on the condition that the emerging issues are regularly reported to RMEC for information and advice.

The new format of Fishery Updates will be developed over the next few months and will be used in the next set of Fishery Updates to be presented in the spring.

Opal Squid

Specific values for landings and landed value in 2000 are considered to be confidential, as only 1 vessel was active in the fishery that year. Landings were less than 10 t. The reasons for declines in recent years are unknown, either related to reduced fishing effort, or reduced reporting, or changes in opal squid distribution which would affect the opportunistic fishing practiced by harvesters.

Assessment activity is limited to logbook data collection and management, and to inspection of samples occasionally provided by fishers.

Issues in this fishery remain unchanged from previous years. This is the last unlimited entry invertebrate fishery. The only mechanism in place to manage increased effort if that were to occur is closures. This is a data limited fishery with insufficient biological information on the distribution or biomass of the stock(s). Catch reporting is unsatisfactory. There is no information about bycatch in the fishery although it is anecdotally reported by fishers. There are insufficient resources within the Department to address these issues.

Crab

Overall the Crab Fishery Update changed very little from 1999. The few changes included: 1) the addition of an emerging issue section, to deal with arising issues which may be of concern in the future; 2) changes to the management of the

commercial crab fishery; and, 3) an update of the landings/values/markets section. In addition, the attached tables of catch, effort, and management changes were updated to include the 2000 commercial crab fishery statistics.

The emerging issues section includes the identification of several issues which may prove to be of concern to the crab fishery in the future. These issues include the incidence of crab by-catch in the Skeena River special seine fishery, incidence of soft-shell crab by-catch during the Hecate Strait groundfish trawl fishery, increasing food, social, and ceremonial requirements by First Nations, and the impacts of sea otters on crab populations. The severity of these issues is not resolved, and these issues have been identified for further investigation.

There were few major management changes to the 2001 commercial crab fishery. They included the prohibition to retain soft-shell crab, the opening and closure of the Area A crab fishery using soft-shell data collected as part of the Soft-shell monitoring program, and graduated trap limit entry into the Area I fishery.

Overall catch, effort, value, and price decreased from 1999 to 2000, although the catch per unit effort increased. All areas with the exception of Area A and J saw an increase in catch. The overall decrease in catch is largely a result of the decrease in catch from Area A, an area which accounts for between one half and one third of the total catch in BC. All areas except G and E saw a decrease in effort, accounting for the overall observed decrease. The value of the fishery dropped below \$20 million for the first time since 1993, likely a combination of the decrease in catch and the decrease in average price.

Green Sea Urchin

The green sea urchin fishery in 2000/01 was a continuation of a 2-yr Management plan for the fishery. No major, management changes were implemented during the 2000/01 fishing season. Quotas were achieved in most areas with the exception of a few North Coast areas. One issue that contributed to quotas not being achieved was a request by the Metlakatla First Nations for S35 access to green sea urchin's in Area 4. This led to the Department organizing Stock Assessment Division (StAD) programs in order to reassess stocks in the area. This assessment is still ongoing.

Market prices for green sea urchin's was poor last year, and is expected to remain poor this coming season due to competition from the Russian producers.

An arising issue for green sea urchins will be the issue of aquaculture and wild stock enhancement. Numerous groups have shown interest in this, with the West Coast Green Urchin Association already experimenting with outplanting in the southern gulf area.

STOCK STATUS REPORTS

Three stock status reports were reviewed and approved by the Subcommittee: Red Sea Urchin, Varnish Clams and Manila Clams (Area 7).

**APPENDIX 1: PSARC INVERTEBRATE SUBCOMMITTEE MEETING AGENDA,
NOVEMBER 27 – 29, 2001**

**PSARC Invertebrate Subcommittee Meeting
November 27 - 29, 2001
Seminar Room, PBS, Nanaimo
Agenda**

	27 November Tuesday Start 0900	28 November Wednesday Start 0900	29 November Thursday Start 0900
AM 1	Introduction and Procedures. I2001-06 Quota Options for the Red Sea Urchin Fishery in BC for fishing season 2002/03.	I2001-08 <i>Pandalus danae</i>, Coonstripe shrimp A Review of the Biology and a Recommended Assessment Framework for a Directed Fishery.	Unfinished business from Day 1 & 2 Rapporteur's Reports Day 2
AM 2	Red Sea Urchin SSR Haida Gwaii Region marine invertebrate baseline and invertebrate related management issues.	I2001-09 Further Investigation of the Fisheries Potential of the Exotic Varnish Clam (<i>Nuttallia obscurata</i>) in BC Varnish Clam SSR	Emerging Issues Working Papers for June 2002 Close
PM 1	I2001-07 Evaluation of a Box Crab Trap test in BC.	I2001-10 A Phase '0' Review of the Biology and Fisheries of the Tanner Crab <i>Chionoecetes bairdi</i>.	
PM 2	Fishery Update discussion SWG/PSARC Fishery Updates for: Crab Green Sea Urchin	Fishery Updates for: Opal Squid Manila Clam (Area 7) SSR Rapporteur's Reports Day 1	

APPENDIX 2: PSARC INVERTEBRATE WORKING PAPERS FOR NOVEMBER 2001

No.	Title	Author
I2001-06	Quota Options for the Red Sea Urchin Fishery in British Columbia for fishing season 2002/2003	A. Campbell D. Tzotzos W.C. Hajas L. Barton
I2001-07	Evaluation of a Box Crab Trap Test in British Columbia	Z. Zhang
I2001-08	<i>Pandalus danae</i> , Coonstripe shrimp A Review of the Biology and a Recommended Assessment Framework for a Directed Fishery	J. S. Dunham J.A. Boutillier
I2001-09	Further Investigation of the Fisheries Potential of the Exotic Vamish Clam (<i>Nuttallia obscurata</i>) in British Columbia	G. Gillespie B. Rusch S.J. Gormican R. Marshall D. Munroe
I2001-10	A Phase '0' Review of the Biology and Fisheries of the Tanner Crab <i>Chionoecetes bairdi</i> .	G. Krause G. Workman A. Phillips

Reviewers for the PSARC papers presented at this meeting are listed below, in alphabetical order. Their assistance is invaluable in making the PSARC process work.

Barsky, K.	California Fish and Game
Bishop, G.	Alaska Fish and Game
Bourne, N.	DFO, Pacific Region
Campbell, A.	DFO, Pacific Region
Dinnel, P.	Western Washington University
Perry, I.	DFO, Pacific Region
Sizemore, B.	Washington Department of Fish and Wildlife
Workman, G.	DFO, Pacific Region
Zhang, Z.	DFO, Pacific Region

**APPENDIX 3: PARTICIPANTS AT INVERTEBRATE SUBCOMMITTEE MEETING,
NOVEMBER 27 – 29, 2001**

Subcommittee Chair:
PSARC Chair:

Kim West
Max Stocker

DFO Participants	Tues	Wed	Thurs
* Subcommittee Members			
Adkins, B.*		✓	
Barton, L.	✓		
Bornhold, B.*	✓	✓	✓
Bourne, N.		✓	
Boutillier, J.*	✓	✓	
Bureau, D.	✓		
Campagna, S.	✓	✓	
Campbell, A.*	✓	✓	
Clark, D.	✓	✓	✓
Convey, L.		✓	
Drinkwater, A.	✓	✓	✓
Dunham, J.	✓	✓	✓
Genn, L.		✓	
Hajas, W.	✓	✓	
Hand, C.*	✓	✓	✓
Harbo, R.*	✓	✓	✓
Heath, B.*		✓	
Jamieson, G.*		✓	
Kim, E.			
Laing, T.		✓	
Lauzier, R.*	✓	✓	✓
Parker, G.*	✓	✓	
Perry, I.*	✓	✓	✓
Phillips, A.		✓	✓
Rogers, J.*	✓	✓	✓
Rusch, B.		✓	
Rutherford, D.	✓	✓	
Spigelman, A.		✓	
Tzotzos, D.	✓	✓	✓
Waddell, B.	✓	✓	
Workman, G.	✓	✓	✓
Zhang, Z.	✓	✓	✓

	Tues	Wed	Thurs
External Participants:			
Holmes, H.	✓		
Jones, R.	✓	✓	
Krause, G.	✓	✓	
Marshall, R.	✓		
Sloan, N.	✓	✓	✓
Observers:			
Erikson, K.		✓	
Featherstone, M.	✓		
Johnson, G.	✓		
McLellan, G.		✓	
Morrison, J.	✓	✓	
Peterson, C.	✓		
Pilcher, S.		✓	

TABLES

Table 1: Red Sea Urchin Bio Mass and Quota Options

Size Limit (mm TD)	Region	Quota 0.2 M Bc					
		M = 0.075		M = 0.10		M = 0.15	
		Mean	Lower 90% CB	Mean	Lower 90% CB	Mean	Lower 90% CB
≥90	North Coast	3553.9	2303.4	4738.5	3071.2	7107.7	4606.9
	South Coast	535.3	226.0	713.8	301.3	1070.7	451.9
	BC	4089.2	2529.4	5452.2	3372.5	8178.4	5058.8
≥95	North Coast	3333.5	2145.4	4444.6	2860.6	6666.9	4290.9
	South Coast	509.0	213.9	678.7	285.2	1018.1	427.8
	BC	3842.5	2359.3	5123.3	3145.7	7685.0	4718.6
≥100	North Coast	3082.1	1953.9	4109.5	2605.2	6164.2	3907.9
	South Coast	474.2	190.4	632.3	253.9	948.4	380.8
	BC	3556.3	2144.3	4741.8	2859.1	7112.7	4288.7
90-130	North Coast	2577.0	1699.7	3436.0	2266.3	5154.0	3399.5
	South Coast	351.2	158.9	468.3	211.9	702.4	317.9
	BC	2928.2	1858.7	3904.3	2478.2	5856.4	3717.3
90-140	North Coast	3074.2	1973.6	4098.9	2631.5	6148.4	3947.2
	South Coast	435.4	183.8	580.5	245.0	870.8	367.5
	BC	3509.6	2157.4	4679.4	2876.5	7019.1	4314.7
95-130	North Coast	2356.6	1548.3	3142.1	2064.4	4713.2	3096.6
	South Coast	324.9	148.4	433.2	197.9	649.8	296.9
	BC	2681.5	1696.8	3575.3	2262.3	5363.0	3393.5
95-140	North Coast	2853.8	1818.9	3805.1	2425.1	5707.6	3637.7
	South Coast	409.1	172.1	545.5	229.5	818.2	344.2
	BC	3262.9	1991.0	4350.5	2654.6	6525.8	3981.9
100-140	North Coast	2602.4	1629.1	3469.9	2172.2	5204.9	3258.3
	South Coast	374.3	149.7	499.0	199.5	748.6	299.3
	BC	2976.7	1778.8	3969.0	2371.7	5953.4	3557.6